FINAL TECHNICAL REPORT

ONR GRANT NO. N00014-90-J-1133

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Title: Upper Ocean Dynamics

The analysis and modeling of a current-temperature mooring data set from the Ocean Storms experiment was completed.

Current meter data from two sites were analyzed for near-inertial motions generated by storms during the ten-month period of the experiment in the northeast Pacific Ocean. The most striking feature of the inertial wave response to storms was the almost instantaneous generation of waves in the mixed layer, followed by a gradual propagation into the thermocline that often lasted many days after the initiation of the storm. The propagation of near-inertial waves generated by three storms in October, January and March were studied by using group propagation theory based on the WKB approximation. It was found that wave frequencies were slightly superinertial, with inertial shifts 1-3% in October and March and around 1% in January. The phase of near-inertial currents propagated upward below the mixed layer, confirming the downward rotation of energy by these waves. The average downward energy flux during the storm periods was between 0.4 and 2.7 m W m^{-2}. The vertical wavelengths indicated by the vertical phase differences ranged from 150 m to 1500 m. The vertical group velocity was estimated from the arrival times of the groups at successive depths. Using this in the dispersion relation, horizontal wavelengths ranging from 140 km to 410 km were obtained. A relation between temperature and velocity that gives the horizontal directionality of internal waves was derived. During the storm periods examined, the propagation directions of near-inertial waves mainly lay between northeast and south, indicating sources west of moorings. The directions tended to rotate clockwise with increasing depth, consistent with the expected effect of earth's curvature. The estimated horizontal wavelength and propagation direction were consistent with the horizontal phase difference between inertial currents at the two sites.

A ray-tracing model based on linear interval wave dynamics and the WKB approximation was developed to study the propagation of near-inertial internal waves generated by the three major storms. The near-inertial response at depths below the mixed layer was viewed as being made up of wave groups that arrived along ray paths from distant generation locations in the mixed layer. Using direction of propagation and wave frequency estimated from the data in the integrated ray path equations, the spatial structures and generation locations of ray paths describing the near-inertial responses at various times and depths were determined. The source locations of the near-inertial waves observed at the two sites were within an area of 150 by 200 km east of storm tracks and west of the moorings, consistent with the movement of the storm systems. The horizontal wavelengths calculated by the model were compared to those estimated from the dispersion relation. This suggested that the observed responses consist of a wide spectrum of near-inertial internal waves. The range they indicated did not agree well. The near-inertial responses described by a group of ray paths either reaching or passing by the sites were overall consistent with the observations, but discrepant in certain details.

The spatial structure of ray paths demonstrated the propagation asymmetry in north-south and vertical directions. The near-inertial energy propagation is eventually equatorward because of the variation of the Coriolis parameter with latitude.

LIST OF PUBLICATIONS

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